[0010] In one aspect, the invention provides a device for forming an array of magnetic particles, the device comprising a substrate comprising a plurality of magnetic regions, wherein the magnetic regions produce a plurality of localized magnetic fields when magnetized, and wherein the localized magnetic fields are sufficient to trap a magnetic particle with a trapping energy at least five times greater than the thermal energy of the particle at room temperature. In certain embodiments of the invention the magnetic regions comprise a magnetic material, e.g., a ferromagnetic material such as cobalt. In certain embodiments of the invention the magnetic regions are rectangular and uniform in size and shape, and are arranged in a regular pattern on the substrate. The invention also provides a device for forming an array of magnetic particles, the device comprising a substrate comprising a plurality of magnetic regions, wherein the localized magnetic regions produce a plurality of localized magnetic fields, and wherein the magnetic regions project above the surface of the substrate.

[0011] The invention further provides a device for forming an array of magnetic particles, the device comprising (i) a nonmagnetic substrate, and (ii) a plurality of magnetic regions located on the substrate, wherein a localized magnetic field exists between adjacent magnetic material regions when magnetized. In addition, the invention provides a device for forming an array of magnetic particles, the device comprising a substrate comprising a plurality of magnetic regions, wherein the magnetic regions produce a plurality of localized magnetic fields when magnetized, and wherein the localized magnetic fields generate forces sufficient to trap a magnetic particle with a trapping energy at least five times greater than the thermal energy of the particle at room temperature. According to certain embodiments of the invention a random array of magnetic particles is formed using any of the above devices. Any of the devices of the invention may comprise one or more of (i) a flux circulator, (ii) integrated photodetectors, and (iii) a microfluidic assembly.

[0012] In another aspect, the invention provides a randomly ordered array of magnetic particles. In certain embodiments of the invention the magnetic particles are magnetic beads, e.g., superparamagnetic beads. The beads may be encoded in any of a variety of ways. According to certain embodiments of the invention a plurality of the beads comprise a detectable moiety such as a fluorescent molecule or a hybridization tag. According to certain embodiments of the invention a plurality of the beads comprise a probe, which may be used, for example, to analyze a sample, e.g., to detect the presence of a target in a sample.

[0013] In another aspect, the invention provides methods of forming an array of magnetic particles comprising contacting any of the devices of the invention with a plurality of magnetic particles. The invention further provides a method of forming an array of magnetic particles comprising contacting magnetic particles with a device comprising magnetic regions that produce localized magnetic fields, whereby a plurality of the magnetic particles are trapped by the localized magnetic fields. According to certain embodiments of the invention the magnetic particles are magnetic beads, e.g., superparamagnetic beads. The invention further provides an array of magnetic particles formed according to any of the preceding methods.

[0014] In another aspect, the invention provides methods of analyzing a sample. One such method comprises (i) contacting the sample with magnetic particles, wherein each of a plurality of the magnetic particles comprises a probe, (ii) forming an array of the magnetic particles, and (iii) determining whether a probe interacts with a target in the sample. Another such method comprises (i) contacting the sample with magnetic particles, wherein each of a plurality of the magnetic particles comprises a probe, (ii) forming an array of the magnetic particles, and (iii) performing a genotyping assay, a hybridization assay, an SBE assay, an OLA assay, an ASPE assay, an allelic PCR assay, an exonuclease assay, and an invasive cleavage assay. Another such method comprises (i) contacting the sample with magnetic particles, wherein each of a plurality of the magnetic particles comprises a probe, (ii) forming an array of the magnetic particles, and (iii) performing an ELISA assay. Various detection methods may be used to detect the beads, probes, and/or targets. Appropriate detection modalities include confocal array scanners and charge coupled devices. The methods may include a step of decoding the beads and/or probes. The methods may be used, for example, to detect the presence of a particular target in a sample and/or to determine the identity of a target in a sample.

[0015] In another aspect, the invention provides a method of fabricating a device comprising steps of (i) providing a substrate and (ii) producing magnetic regions in or on the substrate, wherein the magnetic regions produce a plurality of magnetic fields when magnetized, and wherein the localized magnetic fields are sufficient to trap a magnetic particle with a trapping energy at least five times greater than the thermal energy of the particle at room temperature. Additional fabrication methods are also provided.

[0016] These and other embodiments of the invention and methods of use thereof are further described below.

[0017] This application refers to various patents, publications, scientific articles, books, and documents available on World Wide Web sites on or before Aug. 7, 2001. The contents of all of these items are hereby incorporated by reference in their entirety.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] FIGS. **1**(A) to **1**(D) are side and cross-sectional views illustrating use of the magnetic chip of the invention in a hybridization assay.

[0019] **FIG. 2** shows a conceptual image of a magnetic chip containing diamond-shaped magnetic regions with arrayed beads.

[0020] **FIG. 3** is a schematic view of a portion of a magnetic chip.

[0021] **FIG. 4** shows another schematic view of two adjacent magnetic islands separated by a gap of width g.

[0022] **FIG. 5** shows the calculated magnetic field strengths in the x and y directions, assuming a 3 μm gap spacing (g=3 μm) and rectangular cobalt islands.

[0023] **FIG. 6** shows an Atomic Force Microscope (AFM) image of portions of two adjacent magnetic islands and the gap between them according to one embodiment of the invention. In this figure the length of the gap is approxi-